Contents

In the News

Story 1:
Hubble Makes Surprising Find in Early Universe

Story 2:
Chance of Finding Young Earth-Like Planets Higher Than Previously Thought

Story 3:
Discovery Sheds New Light on Famous Einstein Ring

Departments

The Night Sky

ISS Sighting Opportunities

Space Calendar

NASA-TV Highlights

Food for Thought

Space Image of the Week
New results from the NASA/ESA Hubble Space Telescope suggest the formation of the first stars and galaxies in the early universe took place sooner than previously thought. A European team of astronomers have found no evidence of the first generation of stars, known as Population III stars, as far back as when the universe was just 500 million years old.

The exploration of the very first galaxies remains a significant challenge in modern astronomy. We do not know when or how the first stars and galaxies in the universe formed. These questions can be addressed with the Hubble Space Telescope through deep imaging observations. Hubble allows astronomers to view the universe back to within 500 million years of the big bang. Please check the NASA TV schedule for the latest updates on coverage.

A team of European researchers, led by Rachana Bhatawdekar of ESA (the European Space Agency), set out to study the first generation of stars in the early universe. Known as Population III stars, these stars were forged from the primordial material that emerged from the big bang. Population III stars must have been made solely out of hydrogen, helium and lithium, the only elements that existed before processes in the cores of these stars could create heavier elements, such as oxygen, nitrogen, carbon and iron.

Bhatawdekar and her team probed the early universe from about 500 million to 1 billion years after the big bang by studying the cluster MACS J0416 and its parallel field with the Hubble Space Telescope (with supporting data from NASA's Spitzer Space Telescope and the ground-based Very Large Telescope of the European Southern Observatory). "We found no evidence of these first-generation Population III stars in this cosmic time interval," said Bhatawdekar of the new results.

The result was achieved using the Hubble Space Telescope's Wide Field Camera 3 and Advanced Camera for Surveys, as part of the Hubble Frontier Fields program. This program (which observed six distant galaxy
clusters from 2012 to 2017) produced the deepest observations ever made of galaxy clusters and the galaxies located behind them which were magnified by the gravitational lensing effect, thereby revealing galaxies 10 to 100 times fainter than any previously observed. The masses of foreground galaxy clusters are large enough to bend and magnify the light from the more distant objects behind them. This allows Hubble to use these cosmic magnifying glasses to study objects that are beyond its nominal operational capabilities.

Bhatawdekar and her team developed a new technique that removes the light from the bright foreground galaxies that constitute these gravitational lenses. This allowed them to discover galaxies with lower masses than ever previously observed with Hubble, at a distance corresponding to when the universe was less than a billion years old. At this point in cosmic time, the lack of evidence for exotic stellar populations and the identification of many low-mass galaxies supports the suggestion that these galaxies are the most likely candidates for the reionization of the universe. This period of reionization in the early universe is when the neutral intergalactic medium was ionized by the first stars and galaxies.

"These results have profound astrophysical consequences as they show that galaxies must have formed much earlier than we thought," said Bhatawdekar. "This also strongly supports the idea that low-mass/faint galaxies in the early universe are responsible for reionization."

These results also suggest that the earliest formation of stars and galaxies occurred much earlier than can be probed with the Hubble Space Telescope. This leaves an exciting area of further research for the upcoming NASA/ESA/CSA James Webb Space Telescope — to study the universe's earliest galaxies.

These results are based on a previous 2019 paper by Bhatawdekar et al., and a paper that will appear in an upcoming issue of the Monthly Notices of the Royal Astronomical Society (MNRAS). These results are also being presented at a press conference during the 236th meeting of American Astronomical Society.
Research from the University of Sheffield has found that the chance of finding Earth-like planets in their early stages of formation is much higher than previously thought. The team studied groups of young stars in the Milky Way to see if these groups were typical compared to theories and previous observations in other star-forming regions in space, and to study if the populations of stars in these groups affected the likelihood of finding forming Earth-like planets.

The research, published in *The Astrophysical Journal*, found that there are more stars like the Sun than expected in these groups, which would increase the chances of finding Earth-like planets in their early stages of formation.

In their early stages of formation these Earth-like planets, called magma ocean planets, are still being made from collisions with rocks and smaller planets, which causes them to heat up so much that their surfaces become molten rock.

The team, led by Dr. Richard Parker, included undergraduate students from the University of Sheffield giving them the opportunity to apply the skills learnt on their course to leading published research in their field. Dr. Richard Parker, from the University of Sheffield's Department of Physics and Astronomy, said: "These magma ocean planets are easier to detect near stars like the Sun, which are twice as heavy as the average mass star. These planets emit so much heat that we will be able to observe the glow from them using the next generation of infra-red telescopes.

"The locations where we would find these planets are so-called 'young moving groups' which are groups of young stars that are less than 100 million years old—which is young for a star. However, they typically only contain a few tens of stars each and previously it was difficult to determine whether we had found all of the stars in each group because they blend into the background of the Milky Way galaxy."
"Observations from the Gaia telescope have helped us to find many more stars in these groups, which enabled us to carry out this study."

The findings from the research will help further understanding of whether star formation is universal and will be an important resource for studying how rocky, habitable planets like Earth form. The team now hopes to use computer simulations to explain the origin of these young moving groups of stars.

The research team included undergraduate students Amy Bottrill, Molly Haigh, Madeleine Hole and Sarah Theakston from the University of Sheffield’s Department of Physics and Astronomy.

Molly Haigh said: "Being involved in this project was one of the highlights of our university experience and it was a great opportunity to work on an area of astronomy outside the typical course structure.

"It was rewarding to see a physical application of the computer coding we learnt in our degree by sampling the initial mass distribution of stars and how this can relate to the future of exoplanet detection."

The Department of Physics and Astronomy at the University of Sheffield explores the fundamental laws of the universe and develops pioneering technologies with real-world applications. Researchers are looking beyond our planet to map out distant galaxies, tackling global challenges including energy security, and exploring the opportunities presented by quantum computing and 2-D materials.

Explore further

Astronomers find a way to form 'fast and furious' planets around tiny stars


Journal information: Astrophysical Journal

Source: Phys.org
Determined to find a needle in a cosmic haystack, a pair of astronomers time traveled through archives of old data from W. M. Keck Observatory on Maunakea in Hawaii and old X-ray data from NASA's Chandra X-ray Observatory to unlock a mystery surrounding a bright, lensed, heavily obscured quasar.

This celestial object, which is an active galaxy emitting enormous amounts of energy due to a black hole devouring material, is an exciting object in itself. Finding one that is gravitationally lensed, making it appear brighter and larger, is exceptionally exciting. While slightly over 200 lensed unobscured quasars are currently known, the number of lensed obscured quasars discovered is in the single digits. This is because the feeding black hole stirs up gas and dust, cloaking the quasar and making it difficult to detect in visible light surveys.

Not only did the researchers uncover a quasar of this type, they found the object happens to be the first discovered Einstein ring, named MG 1131+0456, which was observed in 1987 with the Very Large Array network of radio telescopes in New Mexico. Remarkably, though widely studied, the quasar's distance or redshift remained a question mark.

"As we dug deeper, we were surprised that such a famous and bright source never had a distance measured for it," said Daniel Stern, senior research scientist at NASA's Jet Propulsion Laboratory and author of the study. "Having a distance is a necessary first step for all sorts of additional studies, such as using the lens as a tool to measure the expansion history of the universe and as a probe for dark matter."
Stern and co-author Dominic Walton, an STFC Ernest Rutherford Fellow at the University of Cambridge's Institute of Astronomy (UK), are the first to calculate the quasar's distance, which is 10 billion light-years away (or a redshift of $z = 1.849$).

The result is published in today’s issue of The Astrophysical Journal Letters.

"This whole paper was a bit nostalgic for me, making me look at papers from the early days of my career, when I was still in graduate school. The Berlin Wall was still up when this Einstein ring was first discovered, and all the data presented in our paper are from the last millennium," said Stern.

**Methodology**

At the time of their research, telescopes around the planet were shuttered due to the coronavirus pandemic (Keck Observatory has since reopened as of May 16); Stern and Walton took advantage of their extended time at home to creatively keep science going by combing through data from NASA's Wide-field Infrared Survey Explorer (WISE) to search for gravitationally lensed, heavily obscured quasars. While dust hides most active galaxies in visible light surveys, that obscuring dust makes such sources very bright in infrared surveys, such as provided by WISE.

Though quasars are often extremely far away, astronomers can detect them through gravitational lensing, a phenomenon that acts as nature's magnifying glass. This occurs when a galaxy closer to Earth acts as a lens and makes the quasar behind it look extra bright. The gravitational field of the closer galaxy warps space itself, bending and amplifying the light of the quasar in the background. If the alignment is just right, this creates a circle of light called an Einstein ring, predicted by Albert Einstein in 1936. More typically, gravitationally lensing will cause multiple images of the background object to appear around the foreground object.

Once Stern and Walton rediscovered MG 1131+0456 with WISE and realized its distance remained a mystery, they meticulously combed through old data from the Keck Observatory Archive (KOA) and found the Observatory observed the quasar seven times between 1997 and 2007 using the Low Resolution Imaging Spectrometer (LRIS) on the Keck I telescope, as well as the Near-Infrared Spectrograph (NIRSPEC) and the Echellette Spectrograph and Imager (ESI) on the Keck II telescope.

"We were able to extract the distance from Keck's earliest data set, taken in March of 1997, in the early years of the observatory," said Walton. "We are grateful to Keck and NASA for their collaborative efforts to make more than 25 years of Keck data publicly available to the world. Our paper would not have been possible without that."

The team also analyzed NASA's archival data from the Chandra X-ray Observatory in 2000, in the first year after the mission launched.

**Next Steps**

With MG 1131+0456's distance now known, Walton and Stern were able to determine the mass of the lensed galaxy with exquisite precision and use the Chandra data to robustly confirm the obscured nature of the quasar, accurately determining how much intervening gas lies between us and its luminous central regions.

"We can now fully describe the unique, fortuitous geometry of this Einstein ring," said Stern. "This allows us to craft follow-up studies, such as using the soon-to-launch James Webb Space Telescope to study the dark matter properties of the lensing galaxy."
"Our next step is to find lensed quasars that are even more heavily obscured than MG 1131+0456," said Walton. "Finding those needles is going to be even harder, but they're out there waiting to be discovered. These cosmic gems can give us a deeper understanding of the universe, including further insight into how supermassive black holes grow and influence their surroundings," says Walton.

Reference:


Source: Spaceref.com
The Night Sky

FRIDAY, JUNE 5

■ Catch Mercury in twilight! It's under Pollux and Castor this week, as shown below. Mercury is ending its last good evening showing until winter 2021.

Full Moon, exactly so at 3:12 p.m. Eastern Daylight Time. As the stars come out tonight, look to the Moon's right, by roughly a fist at arm's length, for orange Antares and the other, whiter stars of upper Scorpius.

■ The Moon undergoes a slight, almost undetectable penumbral eclipse for East Africa, the Middle East, South and Southeast Asia, and Australia. The Moon's southern side will be very slightly, subtly shaded for maybe 40 minutes centered on 19:25 UT. Map, diagram, and details. Livestream of the event.

SATURDAY, JUNE 6

■ For much of the spring, the Milky Way lies right down out of sight all around the horizon for skywatchers at mid-northern latitudes. But watch the east now! The rich Cassiopeia-Cepheus-Cygnus-Aquila stretch of the Milky Way starts rising up all across the east these nights, earlier and higher each week. A hint for the light-polluted: The Milky Way runs horizontally below bright Vega, through the Summer Triangle.

SUNDAY, JUNE 7

■ Have you ever seen Alpha Centauri? At declination –61°, it's permanently out of sight if you're north of latitude 29° N. But if you're at the latitude of San Antonio, Orlando, or points south, Alpha Cen now skims just above your true horizon due south for a little while shortly after dark.

It does this just about when Alpha Librae, the lower-right of Libra's two brightest stars, is due south over your landscape, i.e. opposite Polaris. At that time, drop your gaze down from there.

Although Alpha Cen is a brilliant magnitude 0.0, the atmospheric extinction at the horizon is so great, along with likely summer haze, that you may want to bring binoculars.

■ Before and during early dawn Monday and Tuesday mornings, the waning gibbous Moon shines with Jupiter and Saturn as shown below. Here you get three top small-telescope sights at once! Plan ahead: The first light of dawn now begins about two hours before sunrise (for mid-northern latitudes).

A small telescope will almost always show all four of Jupiter's big moons, currently magnitudes 4.7 to 5.7. It may also show Saturn's largest and brightest moon Titan, mag 8.6. On Monday and Tuesday mornings, Titan is the speck three or four ring-lengths to Saturn's celestial west or west-southwest.

MONDAY, JUNE 8
The Big Dipper has swung around to hang straight down by its handle high in the northwest these evenings. The middle star of its handle is Mizar, with tiny little Alcor right next to it. On which side of Mizar should you look for Alcor? As always, on the side toward Vega! Which is now the brightest star in the east.

Source:  Sky & Telescope
ISS Sighting Opportunities

For Denver:

<table>
<thead>
<tr>
<th>Date</th>
<th>Visible</th>
<th>Max Height</th>
<th>Appears</th>
<th>Disappears</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fri Jun 5, 9:26 PM</td>
<td>3 min</td>
<td>14°</td>
<td>10° above W</td>
<td>11° above SSW</td>
</tr>
</tbody>
</table>

Sighting information for other cities can be found at NASA’s [Satellite Sighting Information](#)

**NASA-TV Highlights**

*(all times Eastern Daylight Time)*

**June 5, Friday**
1:30 p.m. - SpaceCast Weekly (All Channels)

**June 8, Monday**
11:30 a.m. – International Space Station Expedition 63 in-flight interviews with ABC News and NBC News and NASA astronauts Bob Behnken and Doug Hurley (All Channels)

Watch NASA TV on the Net by going to the [NASA website.](#)
Space Calendar

- Jun 05 - [May 29] Penumbral Lunar Eclipse
- Jun 05 - Comet 28P/Neujmin Closest Approach To Earth (2.490 AU)
- Jun 05 - [May 29] Apollo Asteroid 2020 KA6 Near-Earth Flyby (0.030 AU)
- Jun 05 - Atira Asteroid 418265 (2008 EA32) Closest Approach To Earth (0.592 AU)
- Jun 05 - Asteroid 12542 Laver Closest Approach To Earth (1.983 AU)
- Jun 05 - Asteroid 12759 Joule Closest Approach To Earth (2.246 AU)
- Jun 05 - Mike Brown's 55th Birthday (1965)
- Jun 06 - Comet 389P/Siding Spring At Opposition (1.397 AU)
- Jun 06 - [Jun 04] Apollo Asteroid 2020 LA Near-Earth Flyby (0.010 AU)
- Jun 06 - Aten Asteroid 163348 (2002 NN4) Near-Earth Flyby (0.034 AU)
- Jun 06 - Apollo Asteroid 2020 KO1 Near-Earth Flyby (0.034 AU)
- Jun 06 - Amor Asteroid 2020 KO1 Near-Earth Flyby (0.040 AU)
- Jun 06 - Asteroid 1762 Russell Closest Approach To Earth (2.026 AU)
- Jun 06 - Webinar: Space for Urban Planning
- Jun 06 - Godefroy Wendelin's 440th Birthday (1580)
- Jun 07 - Parker Solar Probe, 5th Perihelion
- Jun 07 - Comet C/2020 K4 (PANSTARRS) Closest Approach To Earth (1.130 AU)
- Jun 07 - Comet C/2020 H3 (Wierchzos) Perihelion (2.286 AU)
- Jun 07 - [Jun 01] Amor Asteroid 2020 KA7 Near-Earth Flyby (0.026 AU)
- Jun 07 - Apollo Asteroid 2020 KK3 Near-Earth Flyby (0.045 AU)
- Jun 07 - Apollo Asteroid 471926 Jormungandr Closest Approach To Earth (0.450 AU)
- Jun 07 - Asteroid 1850 Kohoutek Closest Approach To Earth (0.953 AU)
- Jun 07 - Asteroid 9725 Wainscoat Closest Approach To Earth (1.039 AU)
- Jun 07 - Asteroid 12790 Cernan Closest Approach To Earth (1.191 AU)
- Jun 07 - Asteroid 10101 Fourier Closest Approach To Earth (1.453 AU)
- Jun 07 - Asteroid 2653 Principia Closest Approach To Earth (1.479 AU)
- Jun 07 - Kuiper Belt Object 278361 (2007 JJ43) At Opposition (39.857 AU)
- Jun 08 - [Jun 01] World Oceans Day
- Jun 08 - Comet 249P/LINEAR Closest Approach To Earth (0.429 AU)
- Jun 08 - Hyperbolic Object A/2019 Q2 At Opposition (3.269 AU)
- Jun 08 - Apollo Asteroid 2020 KZ3 Near-Earth Flyby (0.008 AU)
- Jun 08 - Apollo Asteroid 2013 XA22 Near-Earth Flyby (0.020 AU)
- Jun 08 - Asteroid 4444 Escher Closest Approach To Earth (1.094 AU)
- Jun 08 - Amor Asteroid 3199 Nefertiti Closest Approach To Earth (1.965 AU)
- Jun 08 - EuroGEO Webinar
- Jun 08 - 45th Anniversary (1975), Venera 9 Launch (Soviet Venus Orbiter/Lander)
- Jun 08 - 55th Anniversary (1965), Luna 6 Launch (Soviet Moon Flyby)
- Jun 08 - Tim Berners-Lee's 65th Birthday (1955)
- Jun 08 - Friedel Sellschop's 90th Birthday (1930)
- Jun 08 - Giovanni Cassini's 395th Birthday (1625)

Source: JPL Space Calendar

Return to Contents
Food for Thought

Discovering the Inner Life of Lightning from the International Space Station

You have likely seen lightning flash from a storm cloud to strike the ground. Such bolts represent only a small part of the overall phenomenon of lightning, though. The most powerful activity occurs high above the surface, in Earth’s upper atmosphere.

Up there, lightning creates brief bursts of gamma rays that are the most high-energy naturally produced phenomena on the planet. Researchers recently measured these high-energy terrestrial gamma-ray flashes, or TGFs, using instruments on the International Space Station. The work helps reveal the mechanism behind the creation of the bright flashes we call lightning.

The instruments are part of the Atmosphere-Space Interactions Monitor (ASIM), an ESA (European Space Agency) Earth observation facility on the outside of the space station used to study severe thunderstorms and their role in Earth’s atmosphere and climate. ASIM recorded other types of upper-atmospheric lightning known as transient luminous events (TLEs) in addition to TGFs. ASIM’s high-speed instruments helped researchers to determine the sequence of events that produces TGFs, as reported in a paper recently published in the journal Science.

“With ASIM, we see how the atmosphere and clouds bubble like a pot of stew on the stove,” says Torsten Neubert of the National Space Institute, Technical University of Denmark and lead author on the paper. “Convection brings humidity, dust and other particles into the upper atmosphere where they affect Earth’s radiation balance. Lightning is a measure of convection and can be relatively simple to put into weather and climate models.”

Lightning is a rapid discharge of electricity that temporarily equalizes opposite charges within a cloud or between a cloud and the ground. Charging of the cloud is powered by convection, with lighter ice particles carried aloft and heavier particles falling under the pull of gravity. When these particles collide, they exchange charge, and the lighter particles carry positive charge up while heavier particles take negative charge down. The atmosphere acts as an insulator between these electrical fields until the strength of the charge overpowers the insulating properties of the atmosphere. Then the lightning leader – actually a long spark – forms between regions of the cloud or between the cloud and the ground, occurring so rapidly that it is hard for humans to see. When the leader connects to the ground, we see a bright flash of high current: the lightning stroke.

Neubert and his team observed a TGF occurring at the onset of a lightning current pulse, which then generated an elve. Elves are expanding waves of ultraviolet emission in the ionosphere above a thunderstorm,
like cosmic ripples from a pebble dropped into water. Measurements suggested that the onset of the current happens quickly at high amplitude and that the gamma-ray flash is generated by electric fields associated with the lightning leader. These observations provide evidence of a connection between TLEs and TGFs.

When a thunderstorm generates very high energy electrons that burst out into the upper atmosphere, they last only milliseconds but emit X- and gamma-rays that ASIM can measure. The experiment helped pinpoint what happens as these electrons are released.

“As lightning winds its way through a cloud, the atmosphere ahead may break down into a very fast pulse of very high current,” Neurbert says. “In the process, it flings out electrons, which create the bright flashes. Understanding this process opens up the inner life of lightning.”

Because lightning is dangerous, scientists tend to study it in the lab, but that cannot get to its true nature, Neubert adds. “We can use this new information on how high energy radiation is generated to learn more about the processes inside lightning.”

TGFs occur at altitudes well above normal lightning and storm clouds, so measuring them is challenging. As the lowest platform in space, much lower than satellites, the space station places ASIM closer to what it measures. ASIM’s instruments also point directly downward from the space station, making it possible to catch as many of the photons in a lightning flash as possible.

Another space station instrument, NASA’s Lightning Imaging Sensor (LIS), measured characteristics of lightning for 17 years beginning in 1997, but the satellite’s orbit covered only between 35 degrees north and south latitudes, primarily the tropics. An identical LIS mounted on the space station in 2017 expanded that coverage to between 56 degrees north and south latitudes. LIS data helped scientists examine the relationship between lightning and severe weather. Comparing ASIM data with that from LIS and other instruments helps make it more useful for weather predictions, Neubert says.

Ultimately, ASIM helps scientists better understand how thunderstorms affect Earth’s atmosphere.

“We soon will have continuous and almost full global monitoring of lightning from U.S., European and Chinese instruments in geostationary orbit. This coverage will improve weather and climate forecasts, provided you know how to use the data. That is where we hope ASIM helps,” Neubert says. “It’s an incredibly exciting time.”

Source: NASA
Crew Dragon Approaches the International Space Station

Explanation  This image shows the Dragon Endeavour approaching the International Space Station on May 31, 2020, over part of southwestern Turkey—including the coastal city of Demre (gray area below the spacecraft)—in the background. Dragon Endeavour docked successfully with the ISS about nineteen hours after reaching orbit. It arrived at the station’s Harmony port while both were about 262 miles (422 kilometers) above the border of China and Mongolia.

For the first time in nine years, NASA astronauts were launched from American soil on an American rocket, and for the first time in history, those astronauts flew on a commercially built and operated spacecraft.

The SpaceX Crew Dragon spacecraft carrying NASA astronauts Robert Behnken and Douglas Hurley lifted off at 3:22 p.m. EDT on May 30, 2020, from Launch Complex 39A at NASA Kennedy Space Center in Florida. The spacecraft was launched atop a reusable SpaceX Falcon 9 rocket. Behnken and Hurley named their spacecraft Endeavour as a tribute to the first space shuttle that both astronauts had flown aboard. Endeavour also flew the penultimate mission of the Space Shuttle Program, launching in May 2011 from the same pad.

Read the original post, "Astronauts Launch from American Soil," from NASA’s Earth Observatory.

Image Credit & Copyright: NASA

Source: NASA